

<https://helda.helsinki.fi>

---

# Homophilous Friendship Assortment Based on Personality Traits and Cognitive Ability in Middle Childhood : The Moderating Effect of Peer Network Size

Ilmarinen, Ville-Juhani

2017

---

Ilmarinen , V-J , Vainikainen , M-P , Verkasalo , M J & Lonnqvist , J-E 2017 , ' Homophilous Friendship Assortment Based on Personality Traits and Cognitive Ability in Middle Childhood : The Moderating Effect of Peer Network Size ' , European Journal of Personality , vol. 31 , no. 3 , pp. 208-219 . <https://doi.org/10.1002/per.2095>

---

<http://hdl.handle.net/10138/299464>

<https://doi.org/10.1002/per.2095>

---

acceptedVersion

---

*Downloaded from Helda, University of Helsinki institutional repository.*

*This is an electronic reprint of the original article.*

*This reprint may differ from the original in pagination and typographic detail.*

*Please cite the original version.*

Running Head: ECOLOGICAL SENSITIVITY OF PERSONALITY HOMOPHILY

Homophilous friendship assortment based on personality traits and cognitive ability in middle  
childhood: The moderating effect of peer network size

Ville-Juhani Ilmarinen

Institute of Behavioural Science, University of Helsinki, Finland

Mari-Pauliina Vainikainen

Centre for Educational Assessment, University of Helsinki, Finland

Markku Verkasalo

Institute of Behavioural Science, University of Helsinki, Finland

Jan-Erik Lönnqvist

Swedish School of Social Science, University of Helsinki, Finland

Correspondence concerning this paper should be sent to Jan-Erik Lönnqvist, Swedish School of Social Science, University of Helsinki, PO BOX 16, 00014 University of Helsinki, Finland. Phone: +35891911. Email: [jan-erik.lonnqvist@helsinki.fi](mailto:jan-erik.lonnqvist@helsinki.fi)

### Abstract

Even though *homophily* (love of the same) is often thought of as a standard feature of friendships, the empirical evidence for attraction based on personality trait similarity is mixed at best. One reason for the inconsistent findings across studies could be variation in the large scale social environment in which the studies have been conducted. We investigated whether diversity in the everyday social ecologies of seven- to eight-year-old children ( $N = 549$ ) moderates whether friendships are formed on the basis of similar personality traits and similar levels of Cognitive ability. Moderated polynomial regression and response surface analyses showed that classroom size moderated homophily based on Openness to Experience: children similar in Openness were more likely to form friendship ties, but only in larger classrooms. Moreover, we found homophily for Cognitive ability, especially among girls. The results for Openness and Cognitive ability were independent of each other. We discuss the social relevance of trait Openness and the notion that capacity to reciprocate underlies homophily based on Cognitive ability.

Keywords: Homophily, personality, cognitive ability, friendships, childhood, social networks

## **Introduction**

### **Homophily in Personality Traits and Friendship Formation**

Similarity based attraction, also known as homophily, is often thought of as a standard feature of friendships. Indeed, it is commonly observed that friends are similar in various attributes such as age, ethnicity, education and gender (McPherson, Smith-Lovin, & Cook, 2001). Within psychology, homophily attracted considerable research interest in the 1960s and 1970s, and was at that time thought to apply also to personality traits (e.g., Byrne, 1961; Duck, 1975). However, despite the intuitively appealing concept of friends that have similar personalities, the accumulated empirical evidence suggest that, in real-life relationships, interpersonal attraction and friendship formation are not based on dyadic similarity in personality traits. Reviews and meta-analyses suggest that attraction is independent of actual, in contrast to perceived, personality similarity in longer term relationships (in contrast to attraction at first sight; Montoya, Horton, & Kirchner, 2008; van Zalk & Denissen, 2015). Nevertheless, some recent studies have shown personality similarities among real-life friends (Lee et al., 2009) and also that friendship formation depends on similarities in personality traits (Selfhout et al., 2010). Thus, based on the current state of the literature, it is difficult to draw conclusions about the association between personality similarity and real-life friendships.

One explanation for why personality trait homophily in friendships has been reported in some studies but not in others could be that such homophily is sensitive to the surrounding social ecology within which the dyadic acquaintance process takes place. In other words, the large scale social environment may generally affect how smaller social units like friendship dyads are formed. Most importantly, social ecologies could explain how personal characteristics and dyadic

combinations of these characteristics affect friendships. Within personality psychology, personality effects on friendships have, in previous research, been examined from the perspective of the individual (“does personality predict friendship preferences?”; e.g., Asendorpf & Wilpers, 1998) and from the perspective of the dyad (“does personality similarity predict friendship choices?”; e.g., Lee et al., 2009; Montoya et al., 2008; Selfhout et al., 2010; van Zalk & Denissen, 2015). The sociological literature, by contrast, has paid attention to the effects that social environments have on friendships (e.g., Allan, 1993; Adams & Allan, 1998). Integrating the two approaches could help explain why results regarding homophily based on personality traits are as inconsistent as they currently are (see Adams & Blieszner, 1994). It is unlikely that the person, the dyad, or the surrounding social ecology could exclusively explain friendships, but it is the interaction between the person and his or her social environment that is likely to be vital in helping understand the social consequences of personality traits as well as why some environments seem to affect friendships. I.e., it may not be sufficient to examine either the attributes of two individuals (person  $\times$  person - interaction) or their social environments. For a more comprehensive view on friendship this examination needs to be extended to all levels; that is, the individual, the dyad and the social environment (person  $\times$  person  $\times$  environment).

### **Socioecological Preconditions for Personality Homophily**

Social relationships do not suddenly appear in social vacuum, but in the midst of social networks consisting of other individuals and other relationships. These also give natural boundaries to relationship possibilities in everyday social ecologies (excluding online relationships; Adams & Allan, 1998; Kadushin, 2012). Some social environments provide more opportunities to find ideal friends, whereas in other social environments social opportunities and relational mobility

are more limited (Schug, Yuki, Horikawa, & Takemura, 2009). Although human social networks can be described by several attributes (e.g., density, hierarchy, transitivity etc.; Kadushin, 2012), the most straightforward way to understand the richness of opportunities that a social environment provides is its extensiveness; that is, how many individuals belong to the network. We argue that the size of a network is likely to play an important role in affecting the ways lower level social structures, such as friendships, are formed. Because a higher number of individuals in a network gives rise to more natural diversity, more extensive ecologies could be expected to provide richer opportunities in finding partners. In case the homophily principle is true for a given personality trait, then one would expect the pattern of homophilous friendship formation based on this trait to be observed more frequently in environments where the number of possible partners is higher. Empirically establishing the importance of the extensiveness of the social surroundings, Bahns, Pickett, and Crandall (2011) showed that friends tend to be notably more similar in attitudes, beliefs, health behaviors and substance use in a large, as compared to a small, college campus. I.e., a more diverse social context gives rise to less diverse dyadic relationships. However, in that study, only one large and one small campus were compared, which makes it hard to draw definite conclusions regarding the importance of network size as compared to the importance of other social context factors.

School classrooms should provide an ideal testing ground for investigating the possible moderating effects of social network size on homophily based on personality traits. Classrooms form naturally bounded social networks that differ from each other in size but are similar to each other in demographic attributes. Although variation in network size across classrooms may seem trivial in magnitude in comparison to variation in network characteristics that could be found at higher level ecologies such as colleges, the number of unique relationships within

a classroom increases rapidly with additional pupils (*number of relationships* =  $(n^2 - n)/2$ , where  $n$  is the number of pupils in the classroom). For example, in a classroom with 12 students there are 66 unique dyads whereas in classroom with 24 students there are 276 unique dyads. Thus, even within the normal range of children's everyday environments there are remarkable differences in social diversity. This implies that if the homophily principle applies to personality, it should do so especially in large classrooms.

### **Social Relationships and Homophily in Middle Childhood**

Middle childhood – the developmental period spanning from around 6- to 11-years-of-age – is a crucial period in terms of friendship development. Having friends during this period is generally associated with later positive outcomes and adjustment (Hartup & Stevens, 1997; Parker, Rubin, Erath, Wojslawowicz, & Buskirk, 2006; Rubin, Fredstrom, & Bowker, 2008). The development of social cognition and the “self in relation to others” (Del Giudice, Angeleri, & Maneri, 2009; Harter, 1999; Joffe, 1997) make this age period especially interesting from the perspective of friendship formation. Whereas pre-school children are not yet able to grasp the psychological underpinnings of behavior in others or fully understand the consequences of their own behaviors, such capabilities become much more prevalent in middle childhood, as demonstrated, for instance, by increased gossiping regarding other persons' characteristics and relationships (Parker et al., 2006). Moreover, the friendships of second graders are already moderately stable (although stability continues to increase during middle childhood: Berndt & Hoyle, 1985), which suggests a degree of purposefulness in friendship formation – children do not rapidly and randomly change friends, but tend to stick to the same friends. In sum, because friends

start to become important in middle childhood it is a very promising age period in which to investigate how dyadic characteristics affect friendship selection.

Homophily in middle childhood peer relationships has been shown for various attributes, including, e.g., ethnicity, pro-social and anti-social behavior, and socio-economical background (Haselager, Hartup, van Lieshout, & Riksen-Walraven, 1998; Kupersmidt, DeRosier, & Patterson, 1995). One of the most ubiquitous element of middle childhood friendships is gender homophily – both girls and boys almost exclusively form friendship with same-sex peers (Parker et al., 2006). However, to our knowledge, there are no studies that would report on personality trait similarities in middle childhood friendships. This may, in part, be due to the general lack of studies on personality traits and social outcomes around this age, but may also reflect an absence of personality based homophily in the real life friendships of children (thus paralleling the inconsistent findings for adults; see Montoya et al., 2008). However, as argued above, some social environments are more likely to enable assortative friendship selection than others. Focusing on middle childhood is not only theoretically motivated, but also bears with it the practical advantage that an important social environment of children at this age is their own school class.

### **The Role of Cognitive Ability (as Capacity to Reciprocate)**

In friendship formation, similarity in cognitive ability is known to play a more important role than similarity in personality traits (for an early observation of this difference see Richardson, 1939). Indeed, homophily based on cognitive ability has been consistently reported both in adult (Reagor & Clore, 1970; Senn, 1971) and child samples (Tesser, Campbell, & Smith, 1984). The “capacity to reciprocate” (Vigil, 2007) has been suggested to explain homophily based on cognitive ability. Within the theoretical framework of reciprocal altruism, this capacity can be



contrasted with “willingness to reciprocate” (Trivers, 1971; for a more general review of inferences about capacity and willingness in determining interpersonal attraction, see Montoya & Horton, 2014). The key idea in this line of reasoning is that the cognitive abilities of an individual (alongside attributes such as health and wealth that are arguably less important attributes among children) are likely to indicate whether the individual has the capacity to reciprocate in cooperative relationships – i.e. how much the individual is able to contribute. Preferring to form cooperative relationships with partners who do not differ considerably from one’s own capacities has been argued to be beneficial (Vigil, 2007). The rationale for preferring similar others is, in this view, argued to be that lower capacity partners are not able to reciprocally contribute in a relationship and higher capacity partners are more likely to discontinue the relationship. These “defensive” social strategies in friend selection would thus lead to homophily based on perceived capacity to reciprocate. But as Vigil (2007) also noted, these personal capacities need to be communicated to the social environment and also perceived by others for this phenomenon to take place. School classroom are likely to constitute an environment in which peers have a relatively accurate perception of each other’s cognitive abilities. Indeed, peer perceptions of cognitive ability in middle childhood agree with teacher’s perceptions as well as with standardized tests of cognitive ability (Malloy, Yaras, Montvilo, & Sugarman, 1996). Thus, homophily for cognitive ability is to be expected in classroom of seven-to-eight -year old children.

Cognitive ability is correlated with certain personality traits: Openness, Conscientiousness and Emotional Stability (Ackerman & Heggestad, 1997; Moutafi, Furnham, & Crump, 2003; see also Rammstedt, Danner, & Martin, 2016, for a replication in a population representative sample). Thus, to investigate the occurrence of homophily based uniquely on

personality traits or on cognitive ability, these predictor variables were entered not only independently, but also together.

### **The Present Study**

The present study examines, in a sample of seven-to-eight year old children, homophily based on personality traits and on cognitive ability. The children were embedded in classrooms of different sizes, allowing us to investigate the possible moderating effects of classroom size on homophily. We expected homophily to be stronger in larger classrooms, as these could be expected to allow more assortative friendship selection. Furthermore, because different factors may contribute to relationships among girls and boys (Rose & Rudolph, 2006), we also investigated possible gender-differences.

## **Method**

### **Participants and Procedure**

The initial sample consisted of 760 children from 38 school classes (for a detailed description of the sample see Lönngqvist, Verkasalo, & Vainikainen, 2011). All measures used in the present study were available for 580 participants. Regarding peer nominations, participation rates within each class ranged from 77 to 100 ( $M = 94$ ) percent, well above the required 60–70 percent threshold (Cillessen & Marks, 2011) necessary to obtain reliable peer nomination data. Missing data for personality and cognitive ability, however, resulted in rather few participants in six of the 38 classes (in these classes, data was available for only 4 to 10 children), making the sociometer non-representative of the social network of these classrooms (in these classrooms, virtually all same sex dyads were friendship dyads). After exclusion of these six classes, complete data was available for

549 children (280 girls) from 32 classrooms. Personality and Cognitive Ability were assessed during the first grade when children were on average seven years old and sociometric nominations were collected one year later in second grade when children were eight years old.

## Measures

**Personality.** Parents rated their children on 27 personality descriptive items on a scale from 1 to 7. Ten marker items, two for each of the Big Five personality factors, were included in these 27 items. These marker items were adapted from the 10-item Big Five Inventory (BFI; Rammstedt & John, 2007). The remaining seventeen items stemmed from various scales developed by the University of Helsinki Centre for Educational Assessment to measure social behavior and working habits (the items are presented in Table 1 in Lönqvist et al., 2011). These items were used to assess extraversion, openness to experience, conscientiousness, emotional stability, pro-sociality and antagonism (the Big Five agreeableness factor split into two separate factors). Factor-scores constructed by Lönqvist et al. (2011) were used for trait scores.

**Cognitive ability.** The Cognitive ability index was summarized from six different tests for cognitive ability. Spatial reasoning was by measured the Bottles and Draw a House tasks, which were both based on classical Piagetian tasks (Piaget & Inhelder, 1956). Visual memory was assessed with a grid-based measure (Logie & Pearson, 1997) and auditory memory with a task in which the children counted how many times the teacher tapped the desk. Analogical reasoning was assessed by the geometric analogies test (Hosenfeld, van den Boom, & Resing, 1997). Finally, the ability to follow instructions and understand rules was assessed by a grid-based task in which the teacher dictated the correct route. We summarized scores on all tests employing the official summary index developed by the Education Development Centre at the University of Helsinki (for

a complete description of the cognitive ability measures, see Lönnqvist, Vainikainen, & Verkasalo, 2012).

**Sociometric nominations.** Each participant nominated classmates with whom they liked to work and play. Three different nominations were given: “With whom of your classmates do you prefer to... 1. Work in class? 2. Spend time with between classes? 3. Spend time with after school/spend leisure time with?” From the given nominations, a four-category ordinal measure (from 0 to 3) was constructed to indicate the number of nominations sender A gave to receiver B. These scores were calculated for each possible sender-receiver -relationship within class, with both individuals serving once as sender and once as receiver. Because the sociometer included three items, dyadic relationship were examined in three separate but presumably correlated social networks each representing different foci of activity (class work, recess time between classes, leisure time outside of the immediate school environment) (Feld & Carter, 1998). We thus interpret the sociometer as a measure of relationship intensity: Peers who were friends across all foci were considered to have the strongest friendship bond. The ordinal operationalization of friendship nominations was also supported by the distribution: of all sender-receiver combinations ( $N = 9118$ ), 75 % contained no nominations, 7 % contained one, 7 % contained two and 11 % contained all three nominations.

**Classroom size.** Classroom size was simply the number of children in the class. All children in the class were included in the determination of classroom size, regardless of whether the children had missing data on some variables. Class sizes ranged from 14 to 28 ( $M = 20.75$ ,  $SD = 3.38$ ). The distribution of class size did not deviate from normal (Shapiro-Wilk statistic = .97,  $p = .57$ ).

## Statistical Analyses

Sociometric nominations were modeled employing the Social Relation Model (SRM: Kenny, Kashy, & Cook, 2006) using Cumulative Logit Link Mixed Models (CLMM: Christensen, 2015). The dependent variable; that is, the number of nominations from sender A to receiver B (0, 1, 2 or 3), was modeled as an ordinal variable with unconstrained flexible thresholds for each number of nominations (from 0 to 1, from 1 to 2, and from 2 to 3). To account for the dependent structure of the data (the same individuals were members of many dyads), the effects for sender (individual-level tendency to nominate others), receiver (individual-level propensity to receive nominations), dyad (the reciprocity of nominations; that is, within a dyad, when A gives B a certain number of nominations, then B is more likely to give A similar number of nominations), and school class (between-class differences in given nominations) were modeled as random effects.

The dyadic effects of personality traits and cognitive ability on friendship nominations were initially examined one predictor variable (a personality trait or cognitive ability) at a time by entering the five polynomial regression parameters ( $b1$  = receiver score,  $b2$  = sender score,  $b3$  = squared receiver score,  $b4$  = interaction of receiver and sender,  $b5$  = squared sender score) into a model predicting friendship nominations within a dyad (for a thorough discussion of the problems associated with the previously popular use of difference scores as measures of similarity, see Edwards, 2001). From these parameters, response surface parameters were constructed to allow for more clear-cut interpretations of the dyadic effects. The conjoint use of polynomial regression and response surface analysis is currently considered the state-of-the-art method for examining similarity effects (or congruence effect in general; Edwards & Parry, 1993; Nestler, Grimm, & Schönbrodt, 2015; Shanock, Baran, Gentry, Pattison, & Heggstad, 2010). Of the four response

surface parameters ( $a1$  to  $a4$ ), the curvature along the line of dissimilarity ( $a4 = b3 - b4 + b5$ ) was of special interest as it depicts whether dyadic (dis)similarity affects the strength of the dyadic relation. In the cumulative logit link equations used in the present study, the parameters are estimated so that they generalize over each ordinal threshold (the effect is of similar magnitude and significance for 0 to 1, from 1 to 2, and from 2 to 3 nominations). The effects of similarity were thus simultaneously examined for friendship existence, but also for friendship intensity.

Before examining homophily, the effects of gender and classroom size were entered into the model. To begin addressing the question of homophily, we first constructed models in which we entered one new predictor variable (a personality trait or cognitive ability) at a time. These analyses were followed by analyses investigating whether homophily was moderated by classroom size or by the gender composition of the dyad. For analyses, all five polynomial regression parameters were paired with the moderated counterparts of the same parameters (e.g.,  $b1M = b1 \times \text{moderator}$ ,  $b2M = b2 \times \text{moderator} \dots$ ). From the estimated moderated parameters and asymptotic covariance matrices for parameter estimates, linear combinations and standard errors identical to those of the main effects were constructed (for example, the moderation effect for  $a4$  was computed as  $a4M = b3M - b4M + b5M$ ; and  $SEa4 = \sqrt{VAR(b3M) + VAR(b4M) + VAR(b5M) + 2COV(b3M, b5M) - 2COV(b3M, b4M) - 2COV(b4M, b5M)}$  ).

All personality trait measures, the cognitive ability measure, as well as classroom size were standardized to facilitate interpretation and the comparability of different models. All analyses were run in R (R Core Team, 2015) using ordinal package (Christensen, 2015).

## Results

### Unconditional and Preliminary Models

Random effect estimates from the unconditional Thresholds-only model (Table 1) showed that much of the total variation in sociometric nominations was between dyads; more specifically, dyad members tended to give each other a similar number of nominations ( $\hat{\sigma}_{dyad} = 12.58$ ). Markedly less variance in the nominations originated from receiver ( $\hat{\sigma}_{receiver} = 1.51$ ) or sender ( $\hat{\sigma}_{sender} = 1.36$ ). The random effect of classroom was zero, indicating that the average number of nominations in a dyad was similar across classrooms. The above random-components were all included in the cumulative logit mixed models that follow.

In the next model, classroom size and dummy variables for boy- and girl-dyads were entered. Classroom size ( $\beta = -0.31, p < .01$ ) was negatively associated with nominations. The gender of the dyad was strongly associated with sociometric nominations: both girls ( $\beta = 5.95, p < .01$ ) and boys ( $\beta = 6.12, p < .01$ ) almost exclusively nominated peers of the same gender. Cumulative probabilities showed that a girl sent at least one nomination to a specific other girl with a probability of .42 (at least two nominations to that other girl had a probability of .18, whereas the probability that the other girl was nominated all three times was .05), whereas the corresponding probability for boys was .47 (at least two .21, exactly three .06). An additional model contrasting girls' and boys' same gender nominations with each other showed that these did not differ (the overall estimate for same gender was 6.03 ( $p < .01$ ) and the estimate for same gender  $\times$  boys interaction was 0.03 ( $p = .92$ ).

### **Main Effects of Dyadic Combinations of Personality Traits and Cognitive Ability**

The results of polynomial regression models are presented in Table 1. Homophily was not found for any of the personality traits (the  $a4$  estimates ranged from -0.08 to 0.08, all  $p > .45$ ). By contrast, significant homophily was found for Cognitive ability ( $a4 = -0.39, SE = 0.13, p < .01$ ;

see Figure 1c-d, in which, due to the below reported gender difference, this effect is depicted separately for boys and girls).

Regarding linear associations, Extraversion was positively ( $a1 = 0.34$ ,  $SE = 0.12$ ,  $p < .01$ ) and Antagonism negatively ( $a1 = -0.29$ ,  $SE = 0.12$ ,  $p = .01$ ) associated with the number of nominations. Cognitive ability was also positively associated with friendship nominations ( $a1 = 0.24$ ,  $SE = 0.11$ ,  $p = .03$ ). For Extraversion and Cognitive ability, both sender and receiver contributed to the linear increase in nominations, as indicated by non-significant  $a3$ -parameters ( $a3 = -0.08$ ,  $SE = 0.08$ ,  $p = .27$  and  $a3 = 0.12$ ,  $SE = 0.07$ ,  $p = .10$ , respectively). By contrast, the linear effect for Antagonism predominantly originated from receiver effects, as indicated by a significant  $a3$ -parameter ( $a3 = -0.27$ ,  $SE = 0.08$ ,  $p < .01$ ).

### **Classroom Size as a Moderator of Homophily**

Results for models including classroom size as a moderator are presented in Table 2. The interaction between Openness homophily and classroom size ( $a4 \times \text{classroom size} = -0.25$ ,  $SE = 0.12$ ,  $p = .03$ ) was the only one to reach statistical significance (for the other personality traits and for Cognitive ability, the  $a4 \times \text{classroom size}$  estimates ranged from -0.13 to 0.07, all  $p > .29$ ). The negative interaction-term indicates that the homophily parabola was a steep convex in larger classrooms and a less steep cupola in smaller classrooms (see Figure 1a-1b): the  $a4$  estimate in large classrooms (one  $SD$  above the mean) was -0.30 ( $SE = 0.15$ ), whereas the  $a4$  estimate in small classrooms (one  $SD$  below the mean) was 0.20 ( $SE = 0.14$ ).

To examine whether homophily based on Openness was independent of Cognitive ability (for which there was a simple main effect), the main effect of Cognitive Ability and the interaction term between Cognitive ability and classroom size were added to the model including



Openness, classrooms size, and their interaction. This model showed that effects of Openness and Cognitive ability were independent. More specifically, the interaction term between the Openness  $a4$  parameter and classroom size was virtually unaffected ( $a4 \times \text{classroom size}$  for Openness: -0.23,  $SE = 0.10$ ,  $p = .02$ ) by the inclusion of Cognitive ability, and homophily based on Cognitive Ability was not affected by Openness ( $a4$  for Cognitive ability was -0.40,  $SE = 0.13$ ,  $p < .01$ ).

As a brief side note, the other statistically significant interaction effects for classroom-size shown in Table 2 suggest an increasing discrepancy between receiver and sender effects for Openness (the interaction term between the  $a3$ -parameter for Openness and classroom size was 0.18 ( $SE = 0.08$ ;  $p = .03$ ), mostly resulting from open children receiving more nominations in larger classrooms, as shown by the statistically significant interaction effect between the  $b1$ -parameter estimate for Openness and classroom size (0.20,  $SE = 0.08$ ,  $p = .02$ ). A similar moderation effect was found for Antagonism, for which the interaction between the  $a3$ -parameter and classroom size was .16 ( $SE = 0.08$ ,  $p = .03$ ): in larger, as compared to smaller, classrooms antagonistic children received more nominations and sent less nominations.

### **Gender as a Moderator of Homophily**

To investigate possible gender differences, we added gender-moderated polynomial parameters to the above models. The interaction effects for girls' and boys' same-gender dyads were tested in separate models. Besides a significant interaction term between gender and homophily, we required, for the interaction effect to be regarded as meaningful, that the point estimate of the given response surface parameter be significant at  $p < .05$ . This requirement was necessary as the interaction-terms could be significant only because they correct for the extreme fall towards zero of the parameter estimates of cross-gender dyads.

Homophily based on Cognitive ability was stronger among girls ( $a4 \times girls = -0.90$ ,  $SE = 0.26$ ,  $p < .01$ ; the  $a4$  parameter for girls was  $-0.98$ ,  $SE = 0.21$ ,  $p < .01$ ). Gender did not moderate homophily based on personality traits (for all  $a4 \times girls$ , all  $p > .11$ , and for all  $a4 \times boys$ , all  $p > .08$ ). More generally, the only gender-moderated effect of personality traits on friendship nominations concerned Antagonism; the negative linear association between Antagonism and received nominations was stronger among girl-dyads ( $a1 \times girls = -0.56$ ,  $SE = 0.24$ ,  $p = .02$ ; the  $a1$  estimate for girls was  $-0.67$ ,  $SE = 0.24$ ,  $p < .01$ ). The gender-moderated effects of Cognitive ability and Antagonism on friendship are shown in Figures 1c-1d and 1e-1f, respectively.

### Effect sizes for homophily

The magnitudes of the homophily effects were computed employing predicted probabilities at various points along the line of dissimilarity. The probabilities obtained for successive points on this line were contrasted against each other. We chose receiver and sender values ranging from  $-2.00$  to  $2.00$ , with intervals of half a standard deviation ( $.50$ ), as our specific points of interest. Because the line of dissimilarity ( $LODS = a_3 + a_4$ ) has the property  $sender = -receiver$ , these two are always at the same distance to origin and have opposite signs. After calculating the predicted probabilities for friendship dyads with increasing levels of (dis)similarity, the effect size estimates were calculated as odds ratios (OR) against dyads one unit more (dis)similar. For example this would mean that we contrasted point (receiver =  $1$ , sender =  $-1$ ) with point (receiver =  $1.5$ , sender =  $-1.5$ ) – the dyadic distance is decreased by 1 SD when both sender and receiver are 0.50 SD closer to origin. This was necessary to conduct for multiple dyadic values because the effect size is not constant (due the quadratic nature of the homophily effect) but changes as a function of location on the line of dissimilarity. Also, because of slight asymmetries in the response surfaces, we aggregated the predicted probabilities across corresponding points on both sides of the line of similarity (e.g., probabilities were aggregated over points  $perceiver = 1$ ,  $sender = -1$ , and  $perceiver = -1$ ,  $sender = 1$ , and ORs were calculated against the aggregated probability for points  $perceiver = 0.50$ ,  $sender = -.50$ , and  $perceiver = -0.50$ ,  $sender = 0.50$ ).

Predicted probabilities for points along the lines of dissimilarity and ORs between these points are reported in Table 3. For Openness in large classrooms, a one unit increase in total dyadic distance decreased the odds of at least one friendship nomination by 0.93, 0.80, 0.69, and 0.60 for  $|receiver-sender|$  values 0, 1, 2, and 3, respectively. For comparison, the corresponding effects in an average size classroom were 0.99, 0.97, 0.94, and 0.92. The effect size for Openness in large classrooms was of similar magnitude to that of Cognitive ability among boys: ORs against more similar dyads 0.93, 0.79, 0.68, and 0.59 for  $|receiver-sender|$  values 0, 1, 2, and 3, respectively. However, the effect size for Cognitive ability among girls was notably stronger across all points along the line of dissimilarity; the ORs against more similar dyads were 0.78, 0.49, 0.31, and 0.19, respectively.

### Discussion

The present study examined whether the inconsistently observed association between dyadic personality trait similarity and friendship (e.g., Lee et al., 2009; Montoya et al., 2008; Selfhout et al., 2010) would be sensitive to the size of the surrounding social ecology (i.e. classroom size) among seven- to eight-year-old children. The results revealed context-sensitive homophily based on Openness to Experience, that is, children similar in parent rated Openness were more likely to be friends with each other one year later, but this was only true in larger classroom environments, in which there were more social opportunities in terms of possible friendships. Our results also revealed, as expected, homophily based on cognitive ability. Importantly, homophily based on Openness to Experience was independent of homophily based on cognitive ability. Responding to the recent call for research on socioecological psychology (Oishi, 2014), our results provide novel evidence on how the effects of psychological attributes depend on large scale social ecologies.

### **Homophily Based on Openness to Experience**

The results not only supports the importance of Openness to Experience in the social domain (McCrae, 1996), but also give insight regarding the social circumstances in which this trait becomes especially relevant. Some previous studies on personality and existing friendships have shown that friends tend to have similar levels of Openness (Lönqvist & Itkonen, 2016; Lee et al., 2009) and that actual similarities in Openness prospectively predict friendship formation (Selfhout et al., 2010). However, other studies on personality and friendship have failed to find such results (e.g., Ilmarinen, Lönqvist, & Paunonen, 2016; van Zalk & Denissen, 2015). The disparate results of these previous studies could be explained by the number of potential friendships within the relevant social environment, a possibility not examined in these studies. The current results suggest that homophily based on Openness affects friendship formation only when the social environment provides enough diversity; that is, a high enough number of possible social partners.

The sensitivity of similarities between friends to the size of the surrounding social ecology was also observed by Bahns et al. (2011) who compared friendships in two college campuses (small and large). They found that friends were more similar regarding attitudes, beliefs, health behaviors and substance use in the large campus. Our results extend their observation that environments rich in social opportunities leads to less diverse friendships also into the realm of personality traits, or more specifically, Openness. As further differences to the previous study, our results were obtained in notably smaller units of the social environment, i.e. classrooms instead of campuses, and our participants were in middle childhood, as compared to young adults. The most important difference, however, is that the present study sampled over 30 of these social

environments (in contrast to only two), making the socioecological effect less likely to be affected by some other, unmeasured, attributes of these environments.

How does the number of pupils in a classroom actually affect friendship formation?

The individual's need for friends is likely to be similar for the entire range of classroom sizes. Also the preference of similar friends in terms of Openness is also likely to be the same for all classrooms sizes (supportive of this claim, Cheng, Bond and Chan (1995) found that the ideal best friends of adolescents have a level of Openness similar to their own). However, relational mobility may distinguish large classrooms from small classrooms (Oishi, 2014; Schug et al., 2009). That is, how often and how much dyadic ties are established and dissolved in the classroom social network may vary as a function of classroom size. More populous and diverse social environments are marked by high relational mobility, and this has been explained by the higher opportunity costs found in such environments (Schug et al., 2009). In essence, those sticking with their current dissimilar friends pay a higher cost in a larger classroom in the sense of passing on a higher opportunity to find similar peers (a large classroom is likely to provide more opportunities to find similar peers). Also, if one dissolves a friendship, the likelihood of at all establishing a new friendship may be lower in a less populous network. In short, the possibility to be more picky about friends may explain why homophily based on Openness was found only in larger classrooms.

The environmentally moderated homophily effect that we expected for personality traits in general was found only for Openness. This is in concordance with recent studies suggesting that the socioecological relevance of Openness, as compared to other personality traits, is especially high. For example, a study focusing on the moderating influence on residential area (a large scale social environment) on the association between personality traits and life satisfaction, found that in

residential areas of high social diversity and high population density, but not elsewhere, Openness is positively associated with life satisfaction (Jokela, Bleidorn, Lamb, Gosling, & Rentfrow, 2015). Openness is also systematically associated with social attitudes (for a review, see Jost, Glaser, Sulloway & Kruglanski, 2003) and with the personal value dimension Openness to Change versus Conservation (Lee et al., 2009). Such results imply that the construction of ideological bubbles is likely to be associated with social assortment based on Openness (Bakshy, Messing & Adamic, 2015). The results of these studies, conducted with adult samples, could be interpreted as suggesting that similarity of socio-political attitudes plays an important role in explaining homophily based on Openness. However, this is not likely to be the case in the present study – seven-year olds are not likely to adhere to any socio-political ideologies. The homophily effect for Openness was also independent of Cognitive ability, an attribute that is correlated with Openness (Ackerman & Heggestad, 1997; Moutafi et al., 2003; Rammstedt et al., 2016). We therefore interpret our results as suggesting that, in the present sample, the common interests associated with Openness, especially in the creative and aesthetic domains (Furnham & Chamorro-Premuzic, 2004; Wolfradt & Pretz, 2001), are likely to be responsible for social assortment based on Openness.

No ubiquitous homophily or heterophily (opposites attract) effects were found for any of the six personality traits studied (Extraversion, Antagonism, Openness, Conscientiousness, Pro-sociality, and Emotional Stability). Our results are consistent with the notion that regarding personality traits, the similarity-attraction (or dissimilarity-attraction) does not play a major part in real-life friendship formation (Montoya et al., 2008), but can nevertheless be observed for some traits (for results regarding honesty see Cohen, Panter, Turan, Morse, & Kim, 2013; Ilmarinen et al., 2016; Lee et al., 2009) in specific social ecologies that enable assortment based on personality.

### **Homophily Based on Cognitive Ability**

Class-mates with similar levels of cognitive ability were more likely to be friends. Capacity and willingness to reciprocate may play a part in explaining this result (Montoya & Horton, 2014). Cognitive ability may function as a proxy of the capacity to reciprocate, and peers with similar capacity to reciprocate have been argued to prefer each other as friends (Vigil, 2007). In this view, which is based on theories about the evolution of non-kin cooperation and reciprocal altruism (Trivers, 1971; Vigil, 2007), dissimilarity in capacities is avoided because those with higher capacities are less likely to want to reciprocate (that is, they are more likely to dissolve the friendship tie) and those with lower capacities are less likely to be able to reciprocate. The best strategy is thus to form bonds with people similar to one-self in terms of the capacity to reciprocate. This line of thinking, in which cognitive ability functions as a proxy of the capacity to reciprocate, could, as children are able to accurately assess the cognitive abilities of their peers already in middle childhood (Malloy et al., 1996), be relevant in explaining the current results.

The homophily effect for cognitive ability was stronger among girl dyads than boy dyads. Inspection of Figure 1c suggests that some degree of dyadic similarity is almost a necessity for girls to be friends. In general, girls tend to have more relationship-oriented goals such as maintaining relationships and resolving interpersonal problems, whereas boys tend to spend larger portion of their time in larger groups playing sports and games (for a review, see Rose & Rudolph, 2006). The gender difference that we observed could thus be explained by dyadic friendships being more important to girls, which may lead them to be pickier than boys in terms of friends.

### **Limitations and Conclusions**



Although the friendship nominations were collected one year after the personality assessment and cognitive tests, our design does not allow firm conclusions as to causality. Some of those who were friends in second grade could have been friends even prior to first grade and thereby could have influenced each other's personality or cognitive development. However, previous research suggests that peer relations do not become important before the age of six (Hartup & Stevens, 1997; Parker, Rubin, Erath, Wojslawowicz, & Buskirk, 2006; Rubin, Fredstrom, & Bowker, 2008), suggesting that our participants, at the time of the first assessment, when they were seven years old, were not very likely to have been strongly molded by their peers. Nevertheless this possibility cannot be ruled out due to lack of research on peer effects on personality and cognitive development during early childhood. A longitudinal examination of evolving social networks of children could shed light on questions of causality. Nevertheless, the view that similarity has an effect on friendships and not the other way around was strongly supported by recent study considering adults (Bahns, Crandall, Gillath, & Preacher, 2016). The study showed that similarity of friends (in personality, attitudes, behaviors and other relevant attributes) is not a function of the duration of the relationship, and also that similarity affects relationships almost solely at the earlier stages of the acquaintance process between individuals, and that individuals who end up befriending each other do not become more similar in the process.

The sociometer allowed fifteen nominations (five per item) which may have caused children to overestimate their number of friends. Considering that many of the classes were rather small and the scarcity of cross-gender friendships, some of the children may have wanted to list all of their same-sex peers. However, speaking against this possibility, children did not tend to nominate different peers on the three items, as would have been expected had they wished to be as comprehensive as possible. In fact, nominating a peer three times was much more common than

nominating a peer once or twice. Nevertheless, ranked sociometric nominations could provide another perspective on whom children consider as their friends. Somewhat relatedly, larger networks would allow for more powerful tests regarding the influence of individual differences on friendship formation.

Besides limitations, the present study also has some strengths. Being set in middle childhood in a school environment it provides a unique and ecologically valid setting in which to examine friendship formation at an age at which children are rapidly gaining understanding of themselves as members of social relationships and social networks (Del Giudice et al., 2009; Harter, 1999). The results allow the conclusion that personality psychology is likely to be able to contribute strongly to the emerging field of socio-ecological psychology (Oishi, 2014), and vice versa. For example, the finding that Openness has important social consequence that depend on the large-scale social environment adds to the cumulating literature on the broad social importance of Openness (see Jokela et al., 2015).

## References

- Ackerman, P. L., & Heggestad, E. D. (1997). Intelligence, personality, and interests: evidence for overlapping traits. *Psychological Bulletin*, 121, 219–245.
- Adams, R. G., & Blieszner, R. (1994). An integrative conceptual framework for friendship research. *Journal of Social and Personal Relationships*, 11, 163–184.
- Adams, R. G., & Allan, G. (1998). Contextualizing friendship. In R. G. Adams & G. Allan (Eds.), *Placing friendship in context* (pp. 1–17). Cambridge, UK: Cambridge University Press.
- Allan, G. (1993). Social structure and relationships. In S. Duck (Ed.), *Understanding Relationship Processes: Vol. 3. Social context and relationships* (pp. 1–25). Newbury Park, California, US: Sage.
- Asendorpf, J. B., & Wilpers, S. (1998). Personality effects on social relationships. *Journal of Personality and Social Psychology*, 74, 1531–1544.
- Bahns, A. J., Crandall, C. S., Gillath, O., & Preacher, K. J. (2016, February 1). Similarity in relationships as niche construction: Choice, stability, and influence within dyads in a free choice environment. *Journal of Personality and Social Psychology*. Advance online publication. <http://dx.doi.org/10.1037/pspp0000088>
- Bahns, A. J., Pickett, K. M., & Crandall, C. S. (2011). Social ecology of similarity: Big schools, small schools and social relationships. *Group Processes & Intergroup Relations*, 15, 119–131.
- Bakshy, E., Messing, S., & Adamic, L. (2015). Exposure to ideologically diverse news and opinion on Facebook. *Science*, aaa1160).

- Berndt, T. J., & Hoyle, S. G. (1985). Stability and change in childhood and adolescent friendships. *Developmental Psychology*, 21, 1007–1015.
- Byrne, D. (1961). Interpersonal attraction and attitude similarity. *The Journal of Abnormal and Social Psychology*, 62, 713–715.
- Cheng, C., Bond, M. H., & Chan, S. C. (1995). The perception of ideal best friends by Chinese adolescents. *International Journal of Psychology*, 30, 91–108.
- Cillessen, A. H. N., & Marks, P. E. L. (2011). Conceptualizing and measuring popularity. In A. H. N. Cillessen, D. Schwartz, & L. Mayeux (Eds.), *Popularity in the peer system* (pp. 25–56). New York: Guilford Press.
- Cohen, T. R., Panter, A. T., Turan, N., Morse, L., & Kim, Y. (2013). Agreement and similarity in self-other perceptions of moral character. *Journal of Research in Personality*, 47, 816–830.
- Christensen, R. H. B. (2015). ordinal - regression models for ordinal data. R package version 2015.6-28. url: <http://www.cran.r-project.org/package=ordinal/>
- Del Giudice, M., Angeleri, R., & Manera, V. (2009). The juvenile transition: A developmental switch point in human life history. *Developmental Review*, 29, 1–31.
- Duck, S. W. (1975). Personality similarity and friendship choices by adolescents. *European Journal of Social Psychology*, 5, 351–365.
- Edwards, J. R., & Parry, M. E. (1993). On the use of polynomial regression equations as an alternative to difference scores in organizational research. *Academy of Management Journal*, 36, 1577–1613.

- Edwards, J. R. (2001). Ten difference score myths. *Organizational Research Methods*, 4, 265–287.
- Feld, S., & Carter, W. C. (1998). Foci of activity as changing contexts for friendship. In R. G. Adams & G. Allan (Eds.), *Placing friendship in context* (pp. 136–152). Cambridge, UK: Cambridge University Press.
- Furnham, A., & Chamorro-Premuzic, T. (2004). Personality, intelligence, and art. *Personality and Individual Differences*, 36, 705–715.
- Harter, S. (1999). *The construction of the self: A developmental perspective*. New York, US: Guilford Press.
- Hartup, W. W., & Stevens, N. (1997). Friendships and adaptation in the life course. *Psychological Bulletin*, 121, 355–370.
- Haselager, G. J., Hartup, W. W., Lieshout, C. F., & Riksen-Walraven, J. M. A. (1998). Similarities between friends and nonfriends in middle childhood. *Child Development*, 69, 1198–1208.
- Hosenfeld, B., van den Boom, D. C., Resing, W. C. M (1997). Constructing geometric analogies test for the longitudinal testing of elementary school children. *Journal of Educational Measurement*, 34, 367–372.
- Ilmarinen, V. J., Lönnqvist, J. E., & Paunonen, S. (2016). Similarity-attraction effects in friendship formation: Honest platoon-mates prefer each other but dishonest do not. *Personality and Individual Differences*, 92, 153–158.
- Joffe, T. H. (1997). Social pressures have selected for an extended juvenile period in primates. *Journal of Human Evolution*, 32, 593–605.

- Jokela, M., Bleidorn, W., Lamb, M. E., Gosling, S. D., & Rentfrow, P. J. (2015). Geographically varying associations between personality and life satisfaction in the London metropolitan area. *Proceedings of the National Academy of Sciences*, 112, 725–730.
- Jost, J. T., Glaser, J., Sulloway, F., & Kruglanski, A. W. (2003). Political conservatism as motivated social cognition. *Psychological Bulletin*, 129, 339–375
- Kadushin, C. (2012). *Understanding social networks: Theories, concepts, and findings*. New York, US: Oxford University Press.
- Kenny, D. A., Kashy, D. A., & Cook, W. L. (2006). *Dyadic data analysis*. New York, US: Guilford Press.
- Kupersmidt, J. B., DeRosier, M. E., & Patterson, C. P. (1995). Similarity as the basis for children's friendships: The roles of sociometric status, aggressive and withdrawn behavior, academic achievement and demographic characteristics. *Journal of Social and Personal Relationships*, 12, 439–452.
- Lee, K., Ashton, M. C., Pozzebon, J. A., Visser, B. A., Bourdage, J. S., & Ogunfowora, B. (2009). Similarity and assumed similarity in personality reports of well-acquainted persons. *Journal of Personality and Social Psychology*, 96, 460–472.
- Logie, R. H., Pearson, D. G. (1997). The inner eye and the inner scribe of visuo-spatial working memory: Evidence from developmental fractionation. *European Journal of Cognitive Psychology*, 9, 241–257.
- Lönnqvist, J. E., & Itkonen, J. V. (2016). Homogeneity of personal values and personality traits in Facebook social networks. *Journal of Research in Personality*, 60, 24–35.

- Lönnqvist, J. E., Vainikainen, M. P., & Verkasalo, M. (2012). Teacher and parent ratings of seven-year-old children's personality and psychometrically assessed cognitive ability. *European Journal of Personality*, 26, 504–514.
- Lönnqvist, J. E., Verkasalo, M., & Vainikainen, M. P. (2011). Parent–teacher agreement on 7-Year-old children's personality. *European Journal of Personality*, 25, 306–316.
- Malloy, T. E., Yaras, A., Montvilo, R. K., & Sugarman, D. B. (1996). Agreement and accuracy in children's interpersonal perception: A social relations analysis. *Journal of Personality and Social Psychology*, 71, 692–702.
- McCrae, R. R. (1996). Social consequences of experiential openness. *Psychological Bulletin*, 120, 323–337.
- McPherson, M., Smith-Lovin, L., & Cook, J. M. (2001). Birds of a feather: Homophily in social networks. *Annual Review of Sociology*, 415–444.
- Montoya, R. M., Horton, R. S., & Kirchner, J. (2008). Is actual similarity necessary for attraction? A meta-analysis of actual and perceived similarity. *Journal of Social and Personal Relationships*, 25, 889–922.
- Montoya, R. M., & Horton, R. S. (2014). A Two-dimensional model for the study of interpersonal attraction. *Personality and Social Psychology Review*, 18, 59–86.
- Moutafi, J., Furnham, A., & Crump, J. (2003). Demographic and personality predictors of intelligence: A study using the NEO personality inventory and the Myers–Briggs type indicator. *European Journal of Personality*, 17, 79–94.

- Nestler, S., Grimm, K. J., & Schönbrodt, F. D. (2015). The Social consequences and mechanisms of personality: How to analyse longitudinal data from individual, dyadic, round-robin and network designs. *European Journal of Personality*, 29, 272–295.
- Oishi, S. (2014). Socioecological psychology. *Annual Review of Psychology*, 65, 581–609.
- Parker, J. G., Rubin, K. H., Erath, S. A., Wojslawowicz, J. C., & Buskirk, A. A. (2006). Peer relationships, child development, and adjustment. A developmental psychopathology perspective. In D. Cicchetti & D. J. Cohen (Eds.), *Developmental psychopathology. Theory and method* (pp. 420–493). Hoboken, NJ, US: John Wiley and Sons.
- Piaget, J., & Inhelder, B. (1956). *The child's conception of space*. (Translated from French by F. J. Langdon and J. L. Lunzer). London: Routledge & Kegan Paul.
- Rammstedt, B., Danner, D., & Martin, S. (2016). The association between personality and cognitive ability: Going beyond simple effects. *Journal of Research in Personality*, 62, 39–44.
- Rammstedt, B. & John, O. P. (2007). Measuring personality in one minute or less: A 10-item short version of the Big Five Inventory in English and German. *Journal of Research in Personality*, 41, 203–212.
- Reagor, P. A., & Clore, G. L. (1970). Attraction, test anxiety, and similarity-dissimilarity of test performance. *Psychonomic Science*, 18, 219–220.
- Richardson, H. M. (1939). Studies of mental resemblance between husbands and wives and between friends. *Psychological Bulletin*, 36, 104–120.



- Rose, A. J., & Rudolph, K. D. (2006). A review of sex differences in peer relationship processes: Potential trade-offs for the emotional and behavioral development of girls and boys. *Psychological Bulletin*, 132, 98–131.
- Rubin, K., Fredstrom, B., & Bowker, J. (2008). Future directions in... Friendship in childhood and early adolescence. *Social Development*, 17, 1085–1096.
- Schug, J., Yuki, M., Horikawa, H., & Takemura, K. (2009). Similarity attraction and actually selecting similar others: How cross-societal differences in relational mobility affect interpersonal similarity in Japan and the USA. *Asian Journal of Social Psychology*, 12, 95–103.
- Selfhout, M., Burk, W., Branje, S., Denissen, J., Van Aken, M., & Meeus, W. (2010). Emerging late adolescent friendship networks and Big Five personality traits: A social network approach. *Journal of Personality*, 78, 509–538.
- Senn, D. J. (1971). Attraction as a function of similarity-dissimilarity in task performance. *Journal of Personality and Social Psychology*, 18, 120–123.
- Shanock, L. R., Baran, B. E., Gentry, W. A., Pattison, S. C., & Heggstad, E. D. (2010). Polynomial regression with response surface analysis: A powerful approach for examining moderation and overcoming limitations of difference scores. *Journal of Business and Psychology*, 25, 543–554.
- Tesser, A., Campbell, J., & Smith, M. (1984). Friendship choice and performance: Self-evaluation maintenance in children. *Journal of Personality and Social Psychology*, 46, 561–574.
- Trivers, R. L. (1971). The evolution of reciprocal altruism. *Quarterly Review of Biology*, 1, 35–57.

- van Zalk, M., & Denissen, J. (2015). Idiosyncratic versus social consensus approaches to personality: Self-view, perceived, and peer-view similarity. *Journal of Personality and Social Psychology*, *109*, 121–141.
- Vigil, J. M. (2007). Asymmetries in the friendship preferences and social styles of men and women. *Human Nature*, *18*, 143–161.
- Wolfradt, U., & Pretz, J. E. (2001). Individual differences in creativity: Personality, story writing, and hobbies. *European Journal of Personality*, *15*, 297–310.

Table 1. Fixed effects estimates (Top), random effects estimates (Middle), and response surface parameters (Bottom) for Cumulative Logit Link Mixed Models of the predictors of sociometric nominations

|   | Null  | Gender            | EXTR              | ANTA              | OPEN              | CONS              | PROS              | EMST              | COGN              |
|---|-------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|
| <i>Thresholds</i>                               |       |                   |                   |                   |                   |                   |                   |                   |                   |
| 0 1   | 9.49  | 6.25              | 6.34              | 6.37              | 6.27              | 6.24              | 6.30              | 6.16              | 6.15              |
| 1 2   | 11.45 | 7.46              | 7.54              | 7.57              | 7.47              | 7.45              | 7.51              | 7.37              | 7.35              |
| 2 3   | 13.77 | 8.87              | 8.95              | 8.98              | 8.89              | 8.86              | 8.92              | 8.78              | 8.76              |
| <i>Fixed Effects</i>                            |       |                   |                   |                   |                   |                   |                   |                   |                   |
| Girl dyad                                       |       | 5.95**<br>(0.22)  | 5.95**<br>(0.22)  | 5.89**<br>(0.19)  | 5.91**<br>(0.20)  | 5.93**<br>(0.22)  | 5.94**<br>(0.21)  | 5.95**<br>(0.22)  | 5.93**<br>(0.22)  |
| Boy dyad  |       | 6.13**<br>(0.23)  | 6.12**<br>(0.23)  | 6.15**<br>(0.20)  | 6.17**<br>(0.21)  | 6.15**<br>(0.23)  | 6.15**<br>(0.21)  | 6.12**<br>(0.23)  | 6.16**<br>(0.23)  |
| Classroom size                                  |       | -0.31**<br>(0.09) | -0.33**<br>(0.09) | -0.31**<br>(0.08) | -0.31**<br>(0.09) | -0.31**<br>(0.09) | -0.31**<br>(0.09) | -0.31**<br>(0.09) | -0.29**<br>(0.09) |
| <i>Polynomial regression parameters</i>         |       |                   |                   |                   |                   |                   |                   |                   |                   |
| <i>b1</i> (receiver)                            |       |                   | 0.13<br>(0.08)    | -0.28**<br>(0.07) | 0.05<br>(0.08)    | 0.14<br>(0.08)    | 0.03<br>(0.07)    | 0.04<br>(0.07)    | 0.18**<br>(0.07)  |
| <i>b2</i> (sender)                              |       |                   | 0.21**<br>(0.07)  | -0.01<br>(0.07)   | 0.18**<br>(0.07)  | 0.03<br>(0.07)    | 0.09<br>(0.06)    | 0.04<br>(0.06)    | 0.06<br>(0.06)    |
| <i>b3</i> (receiver <sup>2</sup> )              |       |                   | 0.03<br>(0.06)    | 0.10<br>(0.05)    | -0.03<br>(0.04)   | -0.03<br>(0.06)   | 0.00<br>(0.04)    | -0.07<br>(0.05)   | -0.06<br>(0.06)   |
| <i>b4</i> (receiver × sender)                   |       |                   | -0.01<br>(0.07)   | 0.14*<br>(0.07)   | 0.05<br>(0.07)    | 0.07<br>(0.07)    | 0.07<br>(0.07)    | -0.04<br>(0.07)   | 0.23**<br>(0.08)  |
| <i>b5</i> (sender <sup>2</sup> )                |       |                   | 0.04<br>(0.05)    | 0.01<br>(0.04)    | 0.04<br>(0.03)    | 0.01<br>(0.05)    | 0.05<br>(0.04)    | -0.02<br>(0.04)   | -0.10*<br>(0.05)  |
| <i>Random Effects</i>                           |       |                   |                   |                   |                   |                   |                   |                   |                   |
| Dyad  | 12.58 | 3.10              | 3.09              | 3.10              | 3.10              | 3.10              | 3.10              | 3.10              | 3.08              |
| Receiver  | 1.51  | 0.92              | 0.92              | 0.88              | 0.91              | 0.91              | 0.92              | 0.91              | 0.90              |
| Sender  | 1.36  | 0.42              | 0.39              | 0.43              | 0.41              | 0.43              | 0.42              | 0.43              | 0.42              |
| Class   | 0.00  | 0.00              | 0.00              | 0.00              | 0.00              | 0.00              | 0.00              | 0.00              | 0.00              |
| <i>Response surface parameters</i>              |       |                   |                   |                   |                   |                   |                   |                   |                   |
| <i>a1</i> ( <i>b1</i> + <i>b2</i> )             |       |                   | 0.34**<br>(0.12)  | -0.29*<br>(0.12)  | 0.23<br>(0.12)    | 0.17<br>(0.12)    | 0.12<br>(0.11)    | 0.08<br>(0.11)    | 0.24*<br>(0.11)   |
| <i>a2</i> ( <i>b3</i> + <i>b4</i> + <i>b5</i> ) |       |                   | 0.07<br>(0.11)    | 0.25*<br>(0.10)   | 0.05<br>(0.09)    | 0.05<br>(0.11)    | 0.12<br>(0.10)    | -0.13<br>(0.11)   | 0.07<br>(0.10)    |
| <i>a3</i> ( <i>b1</i> – <i>b2</i> )             |       |                   | -0.08<br>(0.08)   | -0.27**<br>(0.08) | -0.14<br>(0.08)   | 0.10<br>(0.08)    | -0.06<br>(0.08)   | -0.01<br>(0.07)   | 0.12<br>(0.07)    |
| <i>a4</i> ( <i>b3</i> – <i>b4</i> + <i>b5</i> ) |       |                   | 0.08<br>(0.11)    | -0.02<br>(0.11)   | -0.04<br>(0.10)   | -0.08<br>(0.12)   | -0.03<br>(0.10)   | -0.05<br>(0.10)   | -0.39**<br>(0.13) |

Note. Values in parentheses are standard errors. EXTR = Extraversion, ANTA = Antagonism, OPEN = Openness to Experience, CONS = Conscientiousness, PROS = Pro-sociality, EMST = Emotional Stability, COGN = Cognitive ability.

\*  $p < .05$ . \*\*  $p < .01$

Table 2. Fixed effects estimates (Top), random effects estimates (Middle), and moderated response surface parameters (Bottom) for Cumulative Logit Link Mixed Models of the predictors of sociometric nominations

|  | EXTR             | ANTA              | OPEN              | CONS             | PROS             | EMST              | COGN              |
|--|------------------|-------------------|-------------------|------------------|------------------|-------------------|-------------------|
| <i>Thresholds</i>                            |                  |                   |                   |                  |                  |                   |                   |
| 0 1  | 6.34             | 6.33              | 6.27              | 6.23             | 6.33             | 6.16              | 6.14              |
| 1 2  | 7.54             | 7.54              | 7.47              | 7.44             | 7.53             | 7.36              | 7.34              |
| 2 3  | 8.95             | 8.95              | 8.88              | 8.85             | 8.94             | 8.78              | 8.75              |
| <i>Fixed Effects</i>                         |                  |                   |                   |                  |                  |                   |                   |
| Girl dyad                                    | 5.96**<br>(0.22) | 5.89**<br>(0.22)  | 5.93**<br>(0.22)  | 5.93**<br>(0.22) | 5.94**<br>(0.22) | 5.95**<br>(0.22)  | 5.93**<br>(0.22)  |
| Boy dyad                                     | 6.12**<br>(0.23) | 6.15**<br>(0.23)  | 6.18**<br>(0.23)  | 6.15**<br>(0.23) | 6.14**<br>(0.23) | 6.12**<br>(0.23)  | 6.16**<br>(0.23)  |
| Classroom size                               | -0.27*<br>(0.13) | -0.38**<br>(0.12) | -0.30**<br>(0.11) | -0.31*<br>(0.12) | -0.25*<br>(0.11) | -0.32**<br>(0.12) | -0.37**<br>(0.12) |
| <i>Polynomial regression parameters</i>      |                  |                   |                   |                  |                  |                   |                   |
| <i>b1</i> (receiver)                         | 0.13<br>(0.08)   | -0.28**<br>(0.07) | 0.05<br>(0.08)    | 0.14<br>(0.08)   | 0.03<br>(0.07)   | 0.04<br>(0.07)    | 0.18**<br>(0.07)  |
| <i>b2</i> (sender)                           | 0.21**<br>(0.07) | -0.01<br>(0.07)   | 0.18**<br>(0.07)  | 0.03<br>(0.07)   | 0.09<br>(0.06)   | 0.04<br>(0.06)    | 0.06<br>(0.06)    |
| <i>b3</i> (receiver <sup>2</sup> )           | 0.03<br>(0.06)   | 0.10<br>(0.05)    | -0.03<br>(0.04)   | -0.03<br>(0.06)  | 0.00<br>(0.04)   | -0.07<br>(0.05)   | -0.06<br>(0.06)   |
| <i>b4</i> (receiver × sender)                | -0.01<br>(0.07)  | 0.14*<br>(0.07)   | 0.05<br>(0.07)    | 0.07<br>(0.07)   | 0.07<br>(0.07)   | -0.04<br>(0.07)   | 0.23**<br>(0.08)  |
| <i>b5</i> (sender <sup>2</sup> )             | 0.04<br>(0.05)   | 0.01<br>(0.04)    | 0.04<br>(0.03)    | 0.01<br>(0.05)   | 0.05<br>(0.04)   | -0.02<br>(0.04)   | -0.10*<br>(0.05)  |
| <i>Moderated regression parameters</i>       |                  |                   |                   |                  |                  |                   |                   |
| <i>b1</i> × classroom size                   | 0.02<br>(0.08)   | 0.07<br>(0.08)    | 0.20*<br>(0.08)   | -0.07<br>(0.08)  | 0.01<br>(0.08)   | -0.01<br>(0.08)   | 0.05<br>(0.08)    |
| <i>b2</i> × classroom size                   | 0.00<br>(0.07)   | -0.09<br>(0.07)   | 0.01<br>(0.07)    | 0.04<br>(0.07)   | -0.01<br>(0.07)  | 0.05<br>(0.07)    | 0.04<br>(0.07)    |
| <i>b3</i> × classroom size                   | 0.01<br>(0.07)   | 0.01<br>(0.05)    | -0.01<br>(0.05)   | -0.03<br>(0.06)  | -0.04<br>(0.05)  | 0.02<br>(0.07)    | 0.04<br>(0.07)    |
| <i>b4</i> × classroom size                   | 0.02<br>(0.08)   | 0.01<br>(0.08)    | 0.21*<br>(0.09)   | 0.13<br>(0.08)   | -0.13<br>(0.08)  | 0.11<br>(0.09)    | 0.01<br>(0.09)    |
| <i>b5</i> × classroom size                   | -0.08<br>(0.06)  | 0.06<br>(0.05)    | -0.03<br>(0.04)   | 0.03<br>(0.05)   | -0.02<br>(0.04)  | 0.00<br>(0.06)    | 0.04<br>(0.06)    |
| <i>Random Effects</i>                        |                  |                   |                   |                  |                  |                   |                   |
| Dyad   | 3.09             | 3.09              | 3.09              | 3.09             | 3.09             | 3.10              | 3.08              |
| Receiver                                     | 0.92             | 0.87              | 0.89              | 0.90             | 0.91             | 0.91              | 0.90              |
| Sender                                       | 0.38             | 0.42              | 0.40              | 0.43             | 0.42             | 0.43              | 0.42              |
| Class  | 0.00             | 0.00              | 0.00              | 0.00             | 0.00             | 0.00              | 0.00              |
| <i>Moderated response surface parameters</i> |                  |                   |                   |                  |                  |                   |                   |
| <i>a1</i> × classroom size                   | 0.01<br>(0.13)   | -0.02<br>(0.12)   | 0.21<br>(0.13)    | -0.03<br>(0.13)  | 0.00<br>(0.12)   | 0.04<br>(0.13)    | 0.09<br>(0.13)    |
| <i>a2</i> × classroom size                   | -0.05<br>(0.14)  | 0.08<br>(0.12)    | 0.17<br>(0.11)    | 0.13<br>(0.12)   | -0.19<br>(0.11)  | 0.13<br>(0.14)    | 0.09<br>(0.12)    |
| <i>a3</i> × classroom size                   | 0.02<br>(0.08)   | 0.16*<br>(0.08)   | 0.18*<br>(0.08)   | -0.11<br>(0.08)  | 0.02<br>(0.08)   | -0.06<br>(0.08)   | 0.02<br>(0.09)    |
| <i>a4</i> × classroom size                   | -0.09<br>(0.13)  | 0.07<br>(0.11)    | -0.25*<br>(0.12)  | -0.13<br>(0.13)  | 0.07<br>(0.11)   | -0.09<br>(0.14)   | 0.07<br>(0.15)    |

Note. Values in parentheses are standard errors. EXTR = Extraversion, ANTA = Antagonism, OPEN = Openness to Experience, CONS = Conscientiousness, PROS = Pro-sociality, EMST = Emotional Stability, COGN = Cognitive ability. \*  $p < .05$ . \*\*  $p < .01$

Table 3. Predicted probabilities (PP) and effect sizes (OR) along the line of dissimilarity for Openness and Cognitive Ability

| Receiver                            | Sender | Openness        |      |                 |      | Cognitive ability |      |           |      |
|-------------------------------------|--------|-----------------|------|-----------------|------|-------------------|------|-----------|------|
|                                     |        | Small classroom |      | Large classroom |      | Girl dyads        |      | Boy dyads |      |
|                                     |        | PP              | OR   | PP              | OR   | PP                | OR   | PP        | OR   |
|                                     | -2.00  | .83             | 1.68 | .15             | 0.58 | .01               | 0.16 | .19       | 0.56 |
|                                     | -1.50  | .74             | 1.52 | .23             | 0.68 | .07               | 0.26 | .29       | 0.65 |
|                                     | -1.00  | .65             | 1.37 | .30             | 0.79 | .24               | 0.42 | .38       | 0.76 |
|                                     | -0.50  | .57             | 1.24 | .35             | 0.91 | .43               | 0.68 | .45       | 0.89 |
|                                     | 0.00   | .52             |      | .37             |      | .52               |      | .48       |      |
|                                     | 0.50   | .49             | 0.89 | .36             | 0.94 | .49               | 0.90 | .47       | 0.97 |
|                                     | 1.00   | .49             | 0.98 | .32             | 0.81 | .35               | 0.55 | .42       | 0.83 |
|                                     | 1.50   | .51             | 1.09 | .24             | 0.70 | .15               | 0.34 | .34       | 0.71 |
|                                     | 2.00   | .55             | 1.20 | .16             | 0.60 | .04               | 0.21 | .24       | 0.61 |
| <i>Absolute distance aggregates</i> |        |                 |      |                 |      |                   |      |           |      |
| Receiver – Sender                   |        |                 |      |                 |      |                   |      |           |      |
| 4                                   |        | .69             | 1.35 | .15             | 0.60 | .02               | 0.19 | .21       | 0.59 |
| 3                                   |        | .62             | 1.26 | .24             | 0.69 | .11               | 0.31 | .32       | 0.68 |
| 2                                   |        | .57             | 1.15 | .31             | 0.80 | .29               | 0.49 | .40       | 0.79 |
| 1                                   |        | .53             | 1.05 | .36             | 0.93 | .46               | 0.78 | .46       | 0.93 |

*Note:* PP = predicted probability at a point in the line of dissimilarity ( $y = -x$ ). OR = Odds Ratio, calculated for each point against a point for which dyadic distance ( $|receiver - sender|$ ) is 1 less (i.e., 4 vs. 3, 3 vs. 2, 2 vs. 1, and 1 vs. 0).

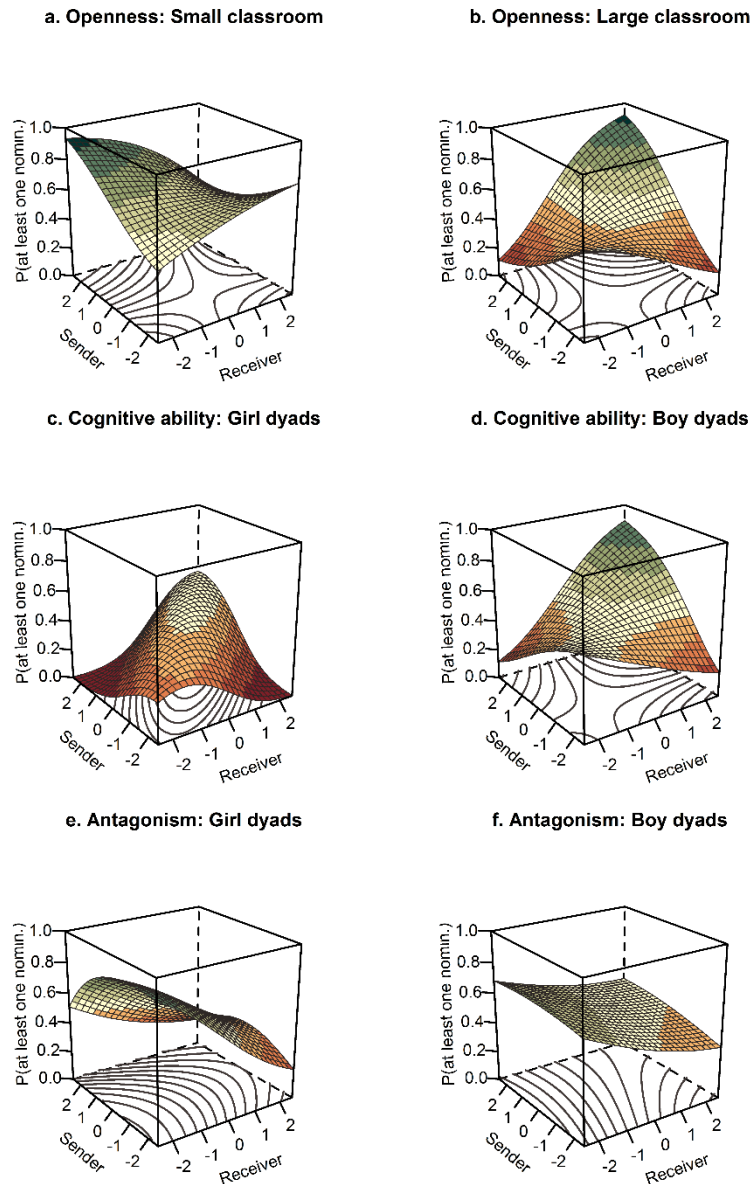


Figure 1. The vertical axis in each panel reflects the probability of at least one friendship nomination.

The topmost row demonstrates dyadic effects for openness as a function of classroom size (panels a and b) plotted for all same-gender dyads. The second row shows dyadic effects for cognitive ability, separately for girls (panel c) and boys (panel d), and the bottom row the respective surfaces for antagonism (panels e and f).